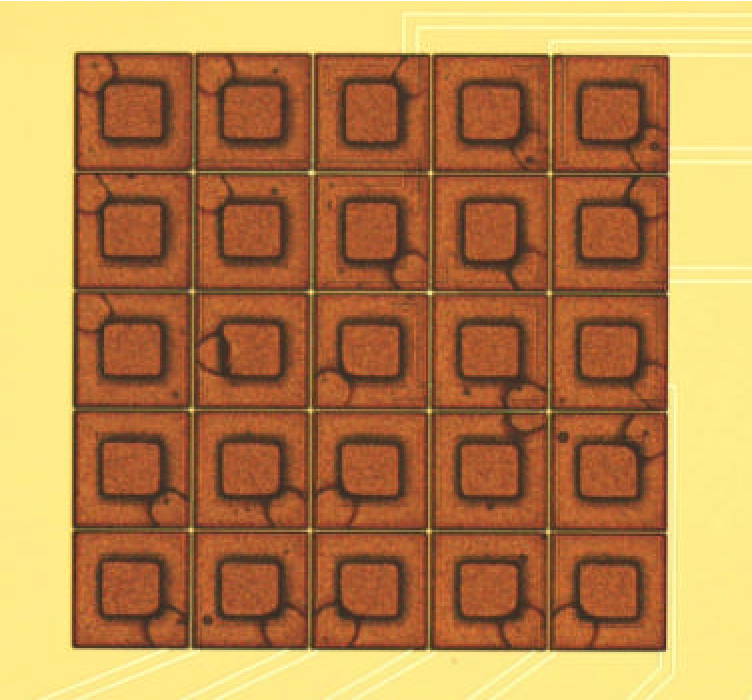
TES Microcalorimeter Development at GSFC



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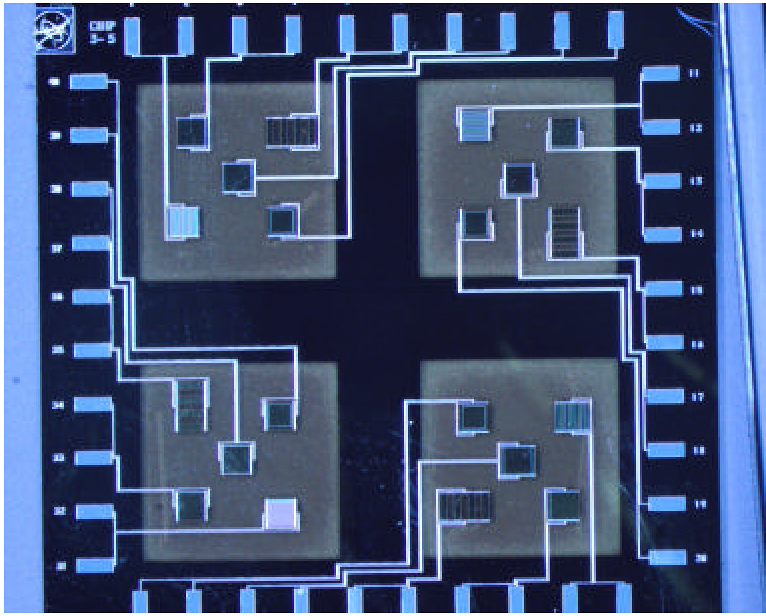


Focus of Recent Activities

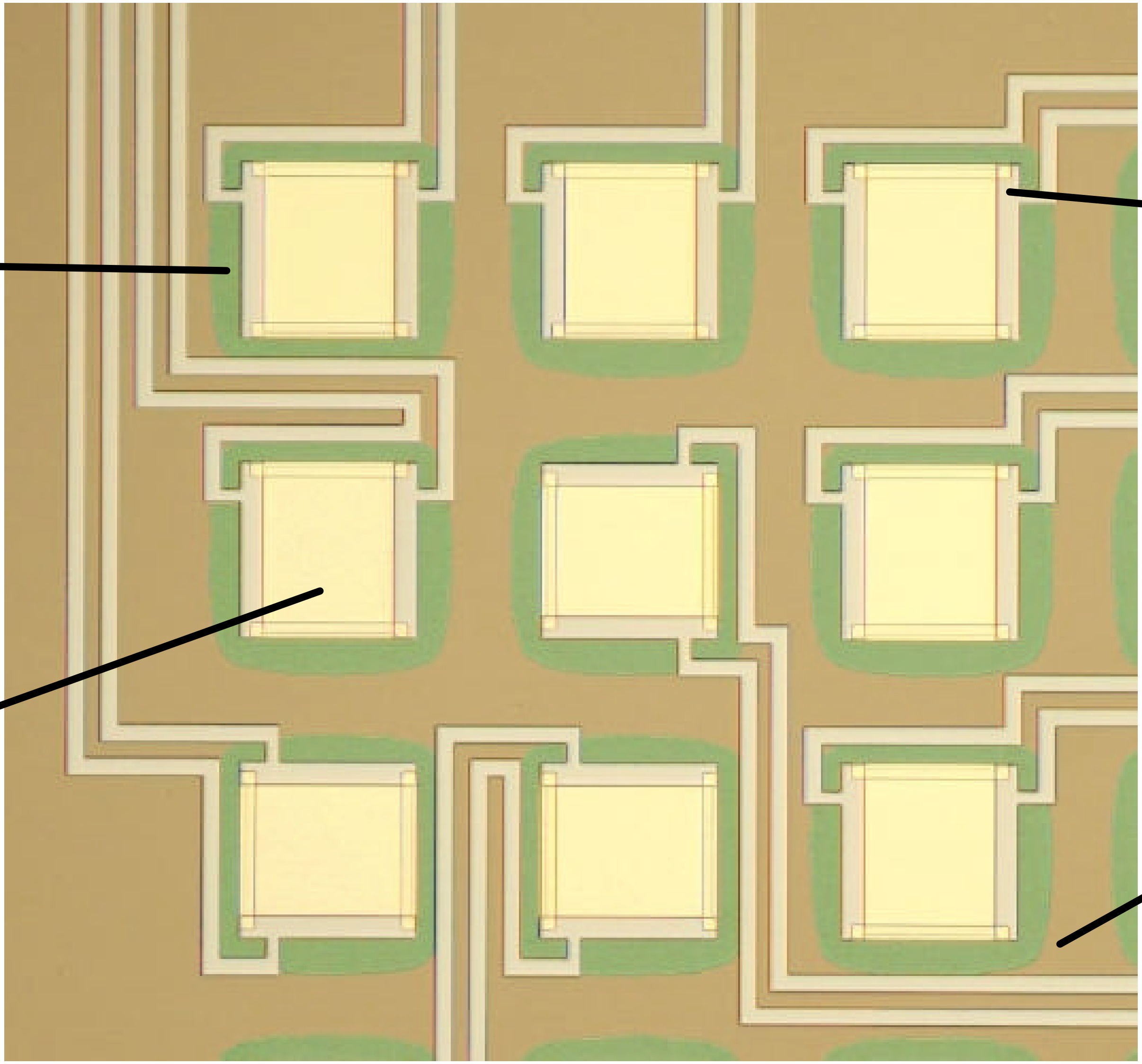
Fabricate and test small arrays of Con-X scale pixels:

- improve the method of making electrical contact to the transition-edge sensors to obtain reliable, low-resistance contacts

- gain experience with devices incorporating the overhanging Bi/Cu absorbers to determine aspects that need refinement

Consider optimizations for devices with basic characteristics (noise, dR/dT) unchanged from what we are now making.

TES pixels without absorbers



Contacts

Mo/Au only in region of TES; overlapping contacts of Nb added

Hard to get adequate step coverage, low R contacts

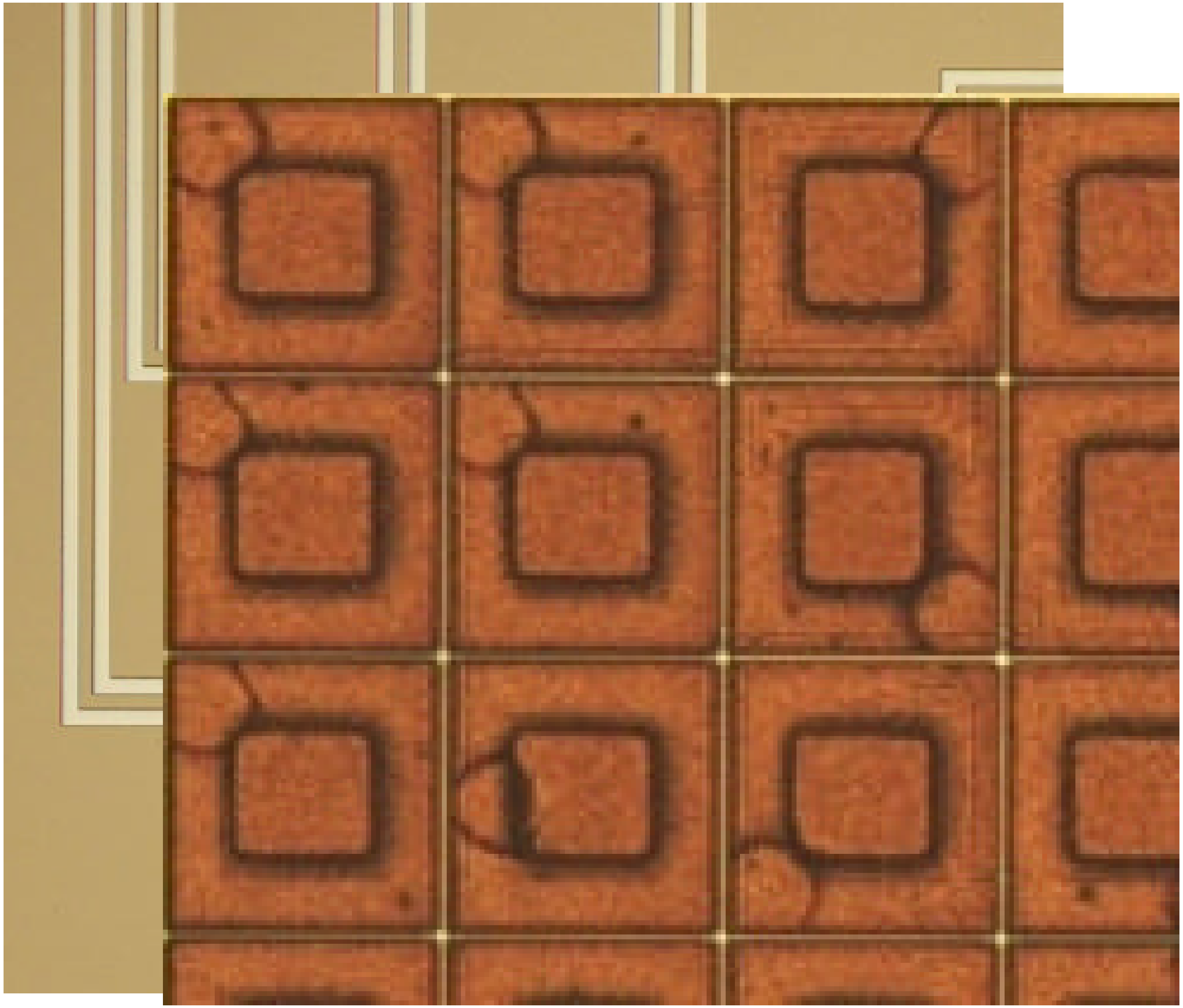
Mo/Au in TES and contacts; extra Mo added to contacts to increase T_c

Trilayer T_c too low; too high electron thermal conductance.

Mo/Au in TES and contacts; Au removed from contacts using ion mill.

After procuring new ion mill and optimizing process, works well.

High QE, high fill-factor absorbers

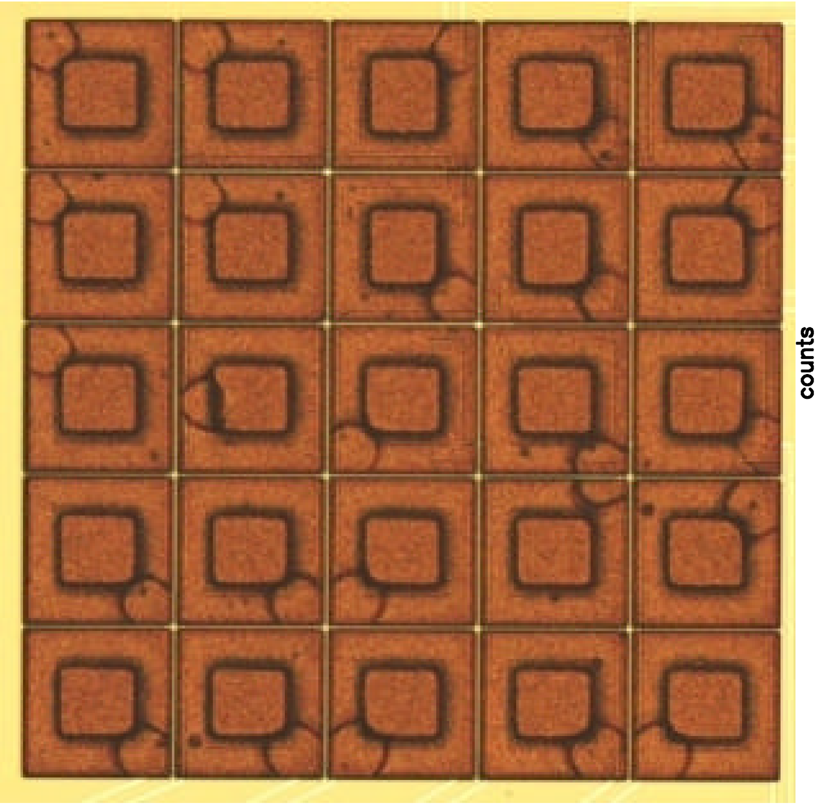


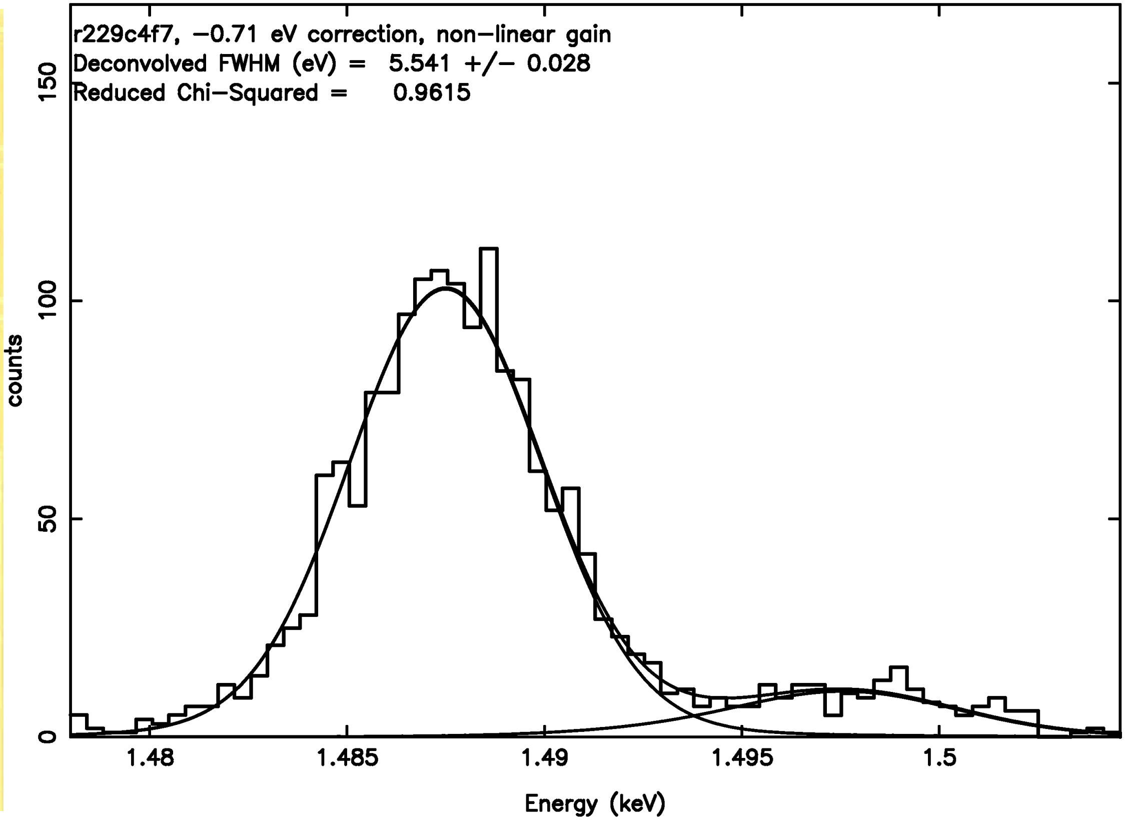
Results from small array

Sub-10-eV resolution obtained in Constellation-X scale TES pixel:

- 5.5 eV at 1.5 keV
- 7.0 eV at 5.9 keV
- Can improve with further design refinement (matching heat capacity to transition width)
- Tested 3 other channels in the array. We have not achieved quite as good performance in those channels. Characterization and spectral acquisitions are still in progress.

5x5 array and Al K spectrum on one channel



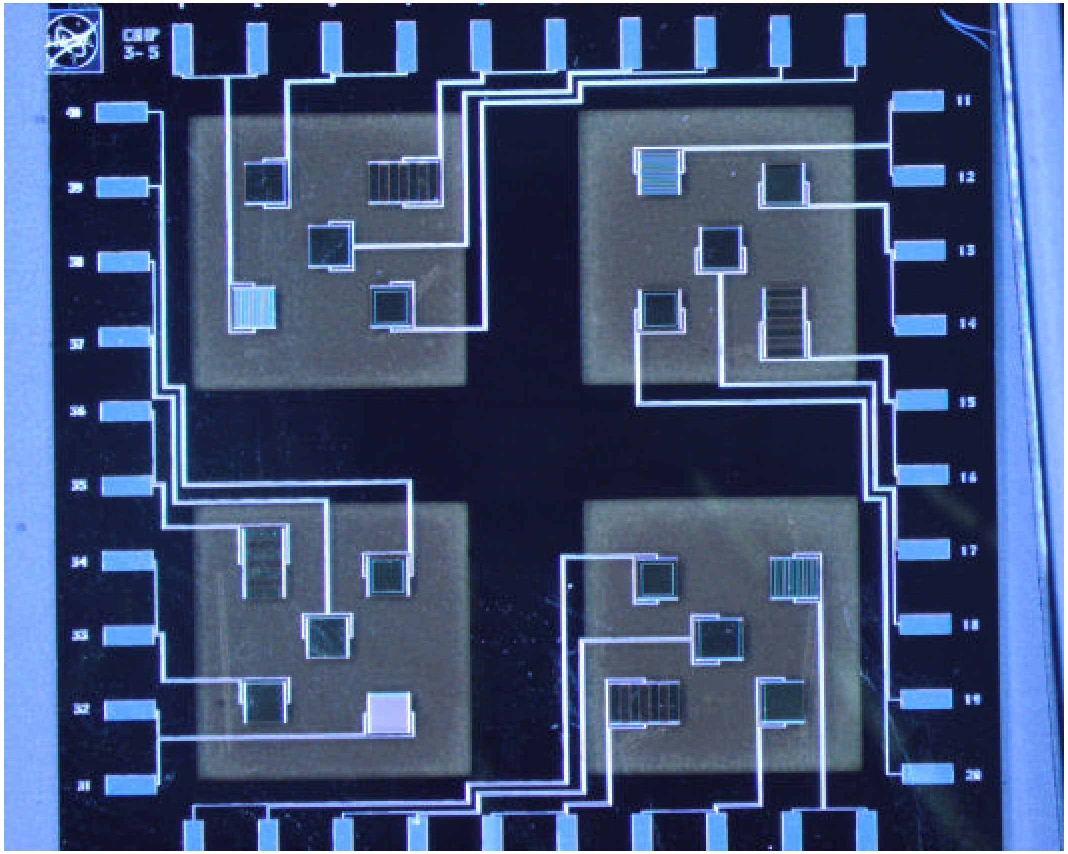


Optimizing a non-ideal detector

Our TES devices exhibit an excess intrinsic white electrical noise that enters the TES equations in the same way as Johnson noise, but is several times larger than Johnson noise.

If the noise level that we now measure in our compact pixels remains unchanged, we still would be able to achieve 2.8 eV resolution by choosing the heat capacity to provide the desired dynamic range given the transition widths that we achieve and an optimum bias point of 30% up the transition.

Noise characterization



Of course we aim to reduce the excess noise. We have fabricated a set of test devices with a variety of geometries and added features to attempt to correlate the measured noise with a device characteristic that we can then adjust to minimize the noise in real devices. These tests will commence in a few days.

Characterization of the absorber and its interface

We have noted that our transition widths have gotten broader since we started integrating absorbers into the fabrication of the compact arrays.

- We don't require achieving a particular transition width (as long as it's not huge, such as > 10 mK), because we can tune the heat capacity to match the transition width. The trick is that we need to know the transition width in advance, thus we need a process that produces reproducible transition widths.
- We have embarked on a materials study of treatments of the Bi/Au interface in order to improve the reproducibility of the transition width. The non-uniform performance of the pixels in the array being studied now *(it's still cold!)* appears to be due almost entirely to differences in the transition shape. We add heat capacity to the absorber (the Cu layers in the Bi) to keep 10 keV x-rays from driving the TES completely to the normal state. With broader transitions, we should be adding less heat capacity. Each of the pixels tested needed less heat capacity than we placed in the Bi/Cu absorber.
- We are just beginning to probe thermalization effects in the

What's next?

- Noise characterization and first iteration towards reducing it
- Improvement of the absorber process
- Continued characterization of the iterated 5x5 arrays
- New run of PoSTs (imaging TES strips)
- LTD-10!
- Preparing 2x8 demo MUX demo platform
- Layout of 8x8 array
- Testing aluminum microvias